Nintendo 64

The **Nintendo 64**,[a] stylized as **NINTENDO64** and abbreviated as **N64**, is Nintendo's third home video game console for the international market. Named for its 64-bit central processing unit, it was released in June 1996 in Japan, September 1996 in North America and Brazil, March 1997 in Europe and Australia, September 1997 in France. It was the last major home console to use the cartridge as its primary storage format until Nintendo's seventh console, the Nintendo Switch, released in 2017.[7] The console was discontinued in mid-2002 following the launch of its successor, the GameCube, in 2001.

Codenamed "Project Reality", the Nintendo 64 design was mostly complete by mid-1995, but its launch was delayed until 1996, when *Time* named it Machine of the Year.[8] It launched with three games: *Super Mario 64* and *Pilotwings 64* (worldwide) and *Saikyō Habu Shōgi* (exclusive to Japan). As part of the fifth generation of gaming, the system competed primarily with the Sony PlayStation and the Sega Saturn. The suggested retail price at its United States launch was US$199.99, and 32.93 million units were sold worldwide. The console was released in a range of colors and designs over its lifetime. In 2015, IGN named it the 9th greatest video game console of all time.[9]

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Nintendo 64	
A charcoal grey Nintendo 64 console and grey controller	
Also known as	Project Reality (code name), Ultra 64 (planned product name)
Developer	Nintendo IRD
Manufacturer	Nintendo
Type	Home video game console
Generation	Fifth generation
Release date	JP: June 23, 1996[3] NA: September 26, 1996 (Limited)[1] September 29, 1996 (Official)[2] BRA: September 29, 1996 EU: March 1, 1997[3] AU: March 1, 1997[3]
Retail availability	1996–2002
Discontinued	WW: April 30, 2002 [4]
Units sold	**Worldwide:** 32.93 million[5] **Japan:** 5.54 million **Americas:** 20.63 million **Europe & Australia:** 6.75 million
Media	Nintendo 64 Game Pak Magnetic disc (64DD)
CPU	64-bit NEC VR4300 @

	93.75 MHz
Memory	4 MB Rambus RDRAM (8 MB with Expansion Pak)
Storage	64 MB Game Pak
Removable storage	256 Kbit (32 KB) Controller Pak
Graphics	SGI RCP @ 62.5 MHz
Sound	16-bit, 48 or 44.1 kHz Stereo
Controller input	Nintendo 64 controller
Power	Switching power supply, 12V and 3.3V DC
Online services	Randnet (Japan only) SharkWire Online (third-party)
Best-selling game	*Super Mario 64*, 11.62 million (as of May 21, 2003)[6]
Predecessor	Super Nintendo Entertainment System
Successor	GameCube
Related articles	Nintendo 64 technical specifications, 64DD, Game Pak, Rumble Pak, games, accessories, color variants, programming characteristics
Website	www.nintendo.com/consumer /systems/nintendo64/index.jsp

History

Background

Around the end of the 1980s, Nintendo led the video game industry with its Nintendo Entertainment System (NES). Although the NES follow-up console, the Super NES (SNES), was successful, sales took a hit from the Japanese recession. Competition from long-time rival Sega, and relative newcomer Sony, emphasized Nintendo's need to develop a successor for the SNES, or risk losing market dominance to its competitors. Further complicating matters, Nintendo also faced a backlash from third-party developers unhappy with Nintendo's strict licensing policies.[11]

Development

Silicon Graphics, Inc. (SGI), a long-time leader in graphics visualization and supercomputing, was interested in expanding its business by adapting its technology into the higher volume realm of consumer products, starting with the video game market. Based upon its MIPS R4000 family of supercomputing and workstation CPUs, SGI developed a CPU requiring a fraction of the resources—consuming only 0.5 watts of power instead of 1.5 to 2 watts, with an estimated target price of US$40 instead of US$80–200.[12] The company created a design proposal for a video game system, seeking an already well established partner in that market. Jim Clark, founder of SGI, initially offered the proposal to Tom Kalinske, who was the CEO of Sega of America. The next candidate would be Nintendo.

The historical details of these preliminary negotiations were controversial between the two competing suitors.[11] Tom Kalinske said that he and Joe Miller of Sega of America were "quite impressed" with SGI's prototype, inviting their hardware team to travel from Japan to meet with SGI. The engineers from Sega Enterprises claimed that their evaluation of the early prototype had uncovered several unresolved hardware issues and deficiencies. Those were subsequently resolved, but Sega had already decided against SGI's design.[13] Nintendo resisted that summary conclusion, arguing that the real reason for SGI's ultimate choice of partner is that Nintendo was a more appealing business partner than Sega.[11] While Sega demanded exclusive rights to the chip, Nintendo was willing to license the technology on a non-exclusive basis.[11] Michael Slater, publisher of *Microprocessor Report* said, "The mere fact of a business relationship there is significant because of Nintendo's phenomenal ability to drive volume. If it works at all, it could bring MIPS to levels of volume [SGI] never dreamed of".[12]

"At the heart of the [Project Reality] system will be a version of the MIPS(r) Multimedia Engine, a chip-set consisting of a 64-bit MIPS RISC microprocessor, a graphics co-processor chip and Application Specific Integrated Circuits (ASICs)". "The product, which will be developed specifically for Nintendo, will be unveiled in arcades in 1994, and will be available for home use by late 1995. The target U.S. price for the home system is below $250". "For the first time, leading-edge MIPS RISC microprocessor technology will be used in the video entertainment industry [and already] powers computers ranging from PCs to supercomputers".

Jim Clark met with Nintendo CEO Hiroshi Yamauchi in early 1993, thus initiating Project Reality.[11] On August 23, 1993, the two companies announced a global joint development and licensing agreement surrounding Project Reality,[14][10] projecting that the yet unnamed eventual product would be "developed specifically for Nintendo, will be unveiled in arcades in 1994, and will be available for home use by late 1995 ... below $250".[10] This announcement coincided with Nintendo's August 1993 Shoshinkai trade show.[15][10]

"Reality Immersion Technology" is the name SGI had given the set of core componentry, which would be first utilized in Project Reality: the MIPS R4300i CPU, the MIPS Reality Coprocessor, and the embedded software.[10][14][16] Some chip technology and manufacturing was provided by NEC, Toshiba, and Sharp.[17] SGI had recently acquired MIPS Computer Systems (renamed to MIPS Technologies), and the two worked together to be ultimately responsible for the design of the Reality Immersion Technology chips[10] under engineering director Jim Foran[18][19] and chief hardware architect Tim Van Hook.[20]

The initial Project Reality game development platform was developed and sold by SGI in the form of its US$100,000[21]–US$250,000[22][20] Onyx supercomputer loaded with the namesake US$50,000[23] RealityEngine2 graphics boards and four 150 MHz R4400 CPUs,[21] and with early Project Reality application and emulation APIs based upon Performer and OpenGL. This graphics supercomputing platform had served as the source design which SGI had reduced down to become the Reality Immersion Technology for Project Reality.[24][20]

Deskside Onyx

The system's game controller was a Super NES controller modified to have a primitive analog joystick and Z trigger. Under maximal secrecy even from the rest of the company, a LucasArts developer said his team would "furtively hide the prototype controller in a cardboard box while we used it. In answer to the inevitable questions about what we were doing, we replied jokingly that it was a new type of controller—a bowl of liquid that absorbed your thoughts through your fingertips. Of course, you had to think in Japanese...[20]

On June 23, 1994, Nintendo announced the new official name of the still unfinished console as "Ultra 64". The first group of elite developers selected by Nintendo was nicknamed the "Dream Team": Silicon Graphics, Inc.; Alias Research, Inc.; Software Creations; Rambus, Inc.; MultiGen, Inc.; Rare, Ltd. and Rare Coin-It Toys & Games, Inc.; WMS Industries, Inc.; Acclaim Entertainment, Inc.; Williams Entertainment, Inc.; Paradigm Simulation, Inc.; Spectrum Holobyte; DMA Design Ltd.; Angel Studios;[25] Ocean; Time Warner Interactive;[26] and Mindscape.[27]

By purchasing and developing upon Project Reality's graphics supercomputing platform, Nintendo and its Dream Team could begin prototyping their games according to SGI's estimated console performance profile, prior to the finalization of the console hardware specifications. When the Ultra 64 hardware was finalized, that supercomputer-based prototyping platform was later supplanted by a much cheaper and fully accurate console simulation board to be hosted within a low-end SGI Indy workstation in July 1995.[10] SGI's early performance estimates based upon its supercomputing platform were ultimately reported to have been fairly accurate to the final Ultra 64 product, allowing LucasArts developers to port their *Star Wars* game prototype to console reference hardware in only three days.[20]

The console's design was publicly revealed for the first time in late Q2 1994. Images of the console displayed the Nintendo Ultra 64 logo and a ROM cartridge, but no controller. This prototype console's form factor would be retained by the product when it eventually launched. Having initially indicated the possibility of utilizing the increasingly popular CD-ROM if the medium's endemic performance problems were solved,[28][29]:77 the company now announced a much faster but space-limited cartridge-based system, which prompted open analysis by the gaming press. The system was frequently marketed as the world's first 64-bit gaming system, often stating the console was more powerful than the first moon landing computers.[30] Atari had already claimed to have made the first 64-bit game console with their Atari Jaguar,[31] but the Jaguar only uses a general 64-bit architecture in conjunction with two 32-bit RISC processors and a 16/32-bit Motorola 68000.[32]

Later in Q2 1994, Nintendo signed a licensing agreement with Midway's parent company which enabled Midway to develop and market arcade games and formed a joint venture company called "Williams/Nintendo" to market Nintendo-exclusive home conversions of these games.[33] The result is two arcade games, *Killer Instinct* and *Cruis'n USA*, which boasted their upcoming debut on the arcade branch of the Nintendo Ultra 64 platform.[34] Completely unrelated to Project Reality's console-based branch of Ultra 64, the arcade branch uses a different MIPS CPU, has no Reality Coprocessor, and uses onboard ROM chips and a hard drive instead of a cartridge.[34][35] *Killer Instinct* features 3D character artwork pre-rendered into 2D form, and CG movie backgrounds that are streamed off the hard drive[36] and animated as the characters move horizontally.

Previously, the plan had been to release the console with the name "Ultra Famicom" in Japan and "Nintendo Ultra 64" in other markets.[37][38] Rumors circulated attributing the name change to the possibility of legal action by Konami's ownership of the Ultra Games trademark. Nintendo said that trademark issues were not a factor, and the sole reason for any name change was to establish a single worldwide brand and logo for the console.[39] The new global name "Nintendo 64" was proposed by *Earthbound* series developer Shigesato Itoi.[40][41] The prefix for the model numbering scheme for hardware and software across the Nintendo 64 platform is "NUS-", a reference to the console's original name of "Nintendo Ultra Sixty-four".[42]

Announcement

The newly renamed Nintendo 64 console was fully unveiled to the public in playable form on November 24, 1995, at Nintendo's 7th Annual Shoshinkai trade show. Eager for a preview, "hordes of Japanese schoolkids huddled in the cold outside ... the electricity of anticipation clearly rippling through their ranks".[24] Photos of the event were disseminated online by *Game Zero* magazine two days later.[43] Official coverage by Nintendo followed later via the *Nintendo Power* website and print magazine.

The console was originally slated for release by Christmas of 1995. In May 1995, Nintendo delayed the release to April 1996.[8][24] Consumers anticipating a Nintendo release the following year at a lower price than the competition reportedly reduced the sales of competing Sega and Sony consoles during the important Christmas shopping season.[44]:24 *Electronic Gaming Monthly* editor Ed Semrad even suggested that Nintendo may have announced the April 1996 release date with this end in mind, knowing in advance that the system would not be ready by that date.[45]

In its explanation of the delay, Nintendo claimed it needed more time for Nintendo 64 software to mature,[11] and for third-party developers to produce games.[8][46] Adrian Sfarti, a former engineer for SGI, attributed the delay to hardware problems; he claimed that the chips underperformed in testing and were being redesigned.[11] In 1996, the Nintendo 64's software development kit was completely redesigned as the Windows-based Partner-N64 system, by Kyoto Microcomputer Co. Ltd. of Japan.[47][48]

The Nintendo 64's release date was later delayed again, to June 23, 1996. Nintendo said the reason for this latest delay, and in particular the cancellation of plans to release the console in all markets worldwide simultaneously, was that the company's marketing studies now indicated that they would not be able to manufacture enough units to meet demand by April 1996, potentially angering retailers in the same way Sega had done with its surprise early launch of the Saturn in North America and Europe.[49]

To counteract the possibility that gamers would grow impatient with the wait for the Nintendo 64 and purchase one of the several competing consoles already on the market, Nintendo ran ads for the system well in advance of its announced release dates, with slogans like "Wait for it..." and "Is it worth the wait? Only if you want the best!"[50]

Release

Popular Electronics called the launch a "much hyped, long-anticipated moment".[44] Several months before the launch, *GamePro* reported that many gamers, including a large percentage of their own editorial staff, were already saying they favored the Nintendo 64 over the Saturn and PlayStation.[51]

The console was first released in Japan on June 23, 1996.[3] Though the initial shipment of 300,000 units sold out on the first day, Nintendo successfully avoided a repeat of the Super Famicom launch day pandemonium, in part by using a wider retail network which included convenience stores.[52] The remaining 200,000 units of the first production run shipped on June 26 and June 30, with almost all of them reserved ahead of time.[53] In the months between the Japanese and North American launches, the Nintendo 64

saw brisk sales on the American grey market, with import stores charging as much as $699 plus shipping for the system.[54] The Nintendo 64 was first sold in North America on September 26, 1996, though having been advertised for the 29th.[1][55] It was launched with just two games in the United States, *Pilotwings 64* and *Super Mario 64*; *Cruis'n USA* was pulled from the lineup less than a month before launch because it did not meet Nintendo's quality standards.[56] In 1994, prior to the launch, Nintendo of America chairman Howard Lincoln emphasized the quality of first-party games, saying "... we're convinced that a few great games at launch are more important than great games mixed in with a lot of dogs".[29]:77 The PAL version of the console was released in Europe on March 1, 1997.[3] According to Nintendo of America representatives, Nintendo had been planning a simultaneous launch in Japan, North America, and Europe, but market studies indicated that worldwide demand for the system far exceeded the number of units they could have ready by launch, potentially leading to consumer and retailer frustration.[57]

Originally intended to be priced at US$250,[8] the console was ultimately launched at US$199.99 to make it competitive with Sony and Sega offerings, as both the Saturn and PlayStation had been lowered to $199.99 earlier that summer.[58][59] Nintendo priced the console as an impulse purchase, a strategy from the toy industry.[60] The price of the console in the United States was further reduced in August 1998.[61]

Promotion

The Nintendo 64's North American launch was backed with a $54 million marketing campaign by Leo Burnett Worldwide (meaning over $100 in marketing per North American unit that had been manufactured up to this point).[62] While the competing Saturn and PlayStation both set teenagers and adults as their target audience, the Nintendo 64's target audience was pre-teens.[63]

To boost sales during the slow post-Christmas season, Nintendo and General Mills worked together on a promotional campaign that appeared in early 1999. The advertisement by Saatchi and Saatchi, New York began on January 25 and encouraged children to buy Fruit by the Foot snacks for tips to help them with their Nintendo 64 games. Ninety different tips were available, with three variations of thirty tips each.[64]

Nintendo advertised its Funtastic Series of peripherals with a $10 million print and television campaign from February 28 to April 30, 2000. Leo Burnett Worldwide was in charge again.[65]

Reception

Critical reception

The Nintendo 64 received generally positive reviews from critics. Reviewers praised the console's advanced 3D graphics and gameplay, while criticizing the lack of games. On G4techTV's *Filter*, the Nintendo 64 was voted up to No. 1 by registered users.

In February 1996, *Next Generation* magazine called the Nintendo Ultra 64 the "best kept secret in videogames" and the "world's most powerful game machine". It called the system's November 24, 1995 unveiling at Shoshinkai "the most anticipated videogaming event of the 1990s, possibly of all time".[66] Previewing the Nintendo 64 shortly prior to its launch, *Time* magazine praised the realistic movement and gameplay provided by the combination of fast graphics processing, pressure-sensitive controller, and the *Super Mario 64* game. The review praised the "fastest, smoothest game action yet attainable via joystick at the service of equally virtuoso motion", where "[f]or once, the movement on the screen feels real".[67]:61 Asked if gamers should buy a Nintendo 64 at launch, buy it later, or buy a competing system, a panel of six *GamePro* editors voted almost unanimously to buy at launch; one editor said gamers who already own a PlayStation and are on a limited budget should buy it later, and all others should buy it at launch.[68]

At launch, the *Los Angeles Times* called the system "quite simply, the fastest, most graceful game machine on the market". Its form factor was described as small, light, and "built for heavy play by kids" unlike the "relatively fragile Sega Saturn". Showing concern for a major console product launch during a sharp, several-year long, decline in the game console market, the review said that the long-delayed Nintendo 64 was "worth the wait" in the company's pursuit of quality. Nintendo's "penchant for perfection" in game quality control was praised, though with concerns about having only two launch titles at retail and twelve expected by Christmas. Describing the quality control incentives associated with cartridge-based development, the *Times* cited Nintendo's position that

cartridge game developers tend to "place a premium on substance over flash", and noted that the launch titles lack the "poorly acted live-action sequences or half-baked musical overtures" which it says tend to be found on CD-ROM games. Praising Nintendo's controversial choice of the cartridge medium with its "nonexistent" load times and "continuous, fast-paced action CD-ROMs simply cannot deliver", the review concluded that "the cartridge-based Nintendo 64 delivers blistering speed and tack-sharp graphics that are unheard of on personal computers and make competing 32-bit, disc-based consoles from Sega and Sony seem downright sluggish".[69]

Time named it their 1996 Machine of the Year, saying the machine had "done to video-gaming what the 707 did to air travel". The magazine said the console achieved "the most realistic and compelling three-dimensional experience ever presented by a computer". *Time* credited the Nintendo 64 with revitalizing the video game market, "rescuing this industry from the dustbin of entertainment history". The magazine suggested that the Nintendo 64 would play a major role in introducing children to digital technology in the final years of the 20th century. The article concluded by saying the console had already provided "the first glimpse of a future where immensely powerful computing will be as common and easy to use as our televisions".[70]:73

Popular Electronics complimented the system's hardware, calling its specifications "quite impressive". It found the controller "comfortable to hold, and the controls to be accurate and responsive".[44]

Developer Factor 5, who created some of the system's most technologically advanced games along with the system's audio development tools for Nintendo, said, "[T]he N64 is really sexy because it combines the performance of an SGI machine with a cartridge. We're big arcade fans, and cartridges are still the best for arcade games or perhaps a really fast CD-ROM. But there's no such thing for consoles yet [as of 1998]".[71]

Sales

The Nintendo 64 was in heavy demand upon its release. David Cole, industry analyst, said "You have people fighting to get it from stores."[58] *Time* called the purchasing interest "that rare and glorious middle-class Cabbage Patch-doll frenzy". The magazine said celebrities Matthew Perry, Steven Spielberg's office, and some Chicago Bulls players called Nintendo to ask for special treatment to get their hands on the console.[72]

During the system's first three days on the market, retailers sold 350,000 of 500,000 available console units.[58] During its first four months, the console yielded 500,000 unit sales in North America.[73] Nintendo successfully outsold Sony and Sega early in 1997 in the United States;[74] and by the end of its first full year, 3.6 million units were sold in the U.S.[75] *BusinessWire* reported that the Nintendo 64 was responsible for Nintendo's sales having increased by 156% by 1997.[74]

After a strong launch year, the decision to use the cartridge format is said to have contributed to the diminished release pace and higher price of games compared to the competition, and thus Nintendo was unable to maintain its lead in the United States. The console would continue to outsell the Sega Saturn throughout the generation, but would trail behind the PlayStation.[76]

In Japan, the console was not as successful, failing to outsell the PlayStation and even the Sega Saturn. Benimaru Itō, a developer for *EarthBound 64* and friend of Shigeru Miyamoto, speculated in 1997 that the Nintendo 64's lower popularity in Japan was due to the lack of role-playing video games.[77]

Nintendo reported that the system's vintage hardware and software sales had ceased by 2004, three years after the GameCube's launch; as of December 31, 2009, the Nintendo 64 had yielded a lifetime total of 5.54 million system units sold in Japan, 20.63 million in the Americas, and 6.75 million in other regions, for a total of 32.93 million units.[5]

Legacy

The Nintendo 64 remains one of the most recognized video game systems in history,[78] and its games still have impact on the games industry. Designed in tandem with the controller, *Super Mario 64* and *The Legend of Zelda: Ocarina of Time* are widely considered by critics and the public to be two of the greatest and most influential games of all time. *GoldenEye 007* is one of the most influential games for the shooter genre.[79]

The Aleck 64 is a Nintendo 64 design in arcade form, designed by Seta in cooperation with Nintendo, and sold from 1998 to 2003 only in Japan.[80]

Games

A total of 388 games were released for the console, though there were a few that were exclusively sold in Japan. For comparison, rivals PlayStation and the Sega Saturn received around 1,100 games and 600 games respectively, while previous Nintendo consoles such as the NES and SNES had 768 and 725 games released in the United States. However, the Nintendo 64 game library included a high number of critically acclaimed and widely sold games.[81] According to TRSTS reports, three of the top five best-selling games in the U.S. for December 1996 were Nintendo 64 games (both of the remaining two were Super NES games).[82] *Super Mario 64* is the best selling game of the generation, with 11 million units sold[83] beating the PlayStation's *Gran Turismo* (at 10.85 million[84]) and *Final Fantasy VII* (at 9.72 million[85]) in sales. The game also received much praise from critics and helped to pioneer three-dimensional control schemes. *GoldenEye 007* was important in the evolution of the first-person shooter, and has been named one of the greatest in the genre.[86] *The Legend of Zelda: Ocarina of Time* set the standard for future 3D action-adventure games[87] and is considered by many to be one of the greatest games ever made.[87][88][89] This trend followed Hiroshi Yamauchi's strategy, announced during his speech at the Nintendo 64's November 1995 unveiling, that Nintendo restrict the number of titles produced for the Nintendo 64 so that developers would focus on developing games to a higher standard instead of trying to outdo their competitors with sheer quantity.[90]

Graphics

The most graphically demanding Nintendo 64 games that arrived on larger 32 or 64 MB cartridges are the most advanced and detailed of the 32-bit/64-bit generation. In order to maximize use of the Nintendo 64 hardware developers had to create their own custom microcode. Nintendo 64 games running on custom microcode benefited from much higher polygon counts in tandem with more advanced lighting, animation, physics and AI routines than its 32-bit competition. *Conker's Bad Fur Day* is arguably the pinnacle of its generation combining multicolored real-time lighting that illuminates each area to real-time shadowing and detailed texturing replete with a full in game facial animation system. The Nintendo 64's graphics chip is capable of executing many more advanced and complex rendering techniques than its competitors. It is the first home console to feature trilinear filtering,[91] which allowed textures to look very smooth. This contrasted with the Saturn and PlayStation, which used nearest-neighbor interpolation[92] and produced more pixelated textures. Overall however the results of the Nintendo cartridge system were mixed and this was tied primarily to its storage medium.

The smaller storage size of ROM cartridges limited the number of available textures. As a result, many games which utilized much smaller 8 or 12 MB cartridges are forced to stretch textures over larger surfaces. Compounded by a limit of 4,096 bytes[93] of on-chip texture memory, the end-result is often a distorted, out-of-proportion appearance. Many titles that feature larger 32 or 64 MB cartridges avoided this issue entirely, notable games include *Resident Evil 2*, *Sin and Punishment: Successor of the Earth*, and *Conker's Bad Fur Day* as they feature more ROM space,[94] allowing for more detailed graphics by utilizing multiple, multi-layered textures across all surfaces.

Game Paks

Nintendo 64 games are ROM cartridge based. Cartridge size varies[94] from 4 to 64 MB. Many cartridges include the ability to save games internally

Nintendo cited several advantages for making the Nintendo 64 cartridge-based.[95] Primarily cited was the ROM cartridges' very fast load times in comparison to disc-based games. While loading screens appear in many PlayStation games, they are rare on the Nintendo 64. Although vulnerable to long-term environmental damage,[95] the cartridges are far more resistant to physical damage than compact discs. Nintendo also cited the fact that cartridges are more difficult to pirate than CDs.[96]

Open and unopened N64 Game Pak

On the downside, cartridges took longer to manufacture than CDs, with each production run (from order to delivery) taking two weeks or more.[98] This meant that publishers of Nintendo 64 games had to attempt to predict demand for a game ahead of its release. They risked being left with a surplus of expensive cartridges for a failed game or a weeks-long shortage of product if they underestimated a game's popularity.[98] The cost of producing a Nintendo 64 cartridge

> The big strength was the N64 cartridge. We use the cartridge almost like normal RAM and are streaming all level data, textures, animations, music, sound and even program code while the game is running. With the final size of the levels and the amount of textures, the RAM of the N64 never would have been even remotely enough to fit any individual level. So the cartridge technology really saved the day.
>
> Factor 5, *Bringing Indy to N64* at IGN[97]

was also far higher than for a CD.[99] Publishers passed these expenses onto the consumer Nintendo 64 games cost an average of $10 more when compared to games produced for rival consoles.[100] The higher cost also created the potential for much greater losses to the game's publisher in the case of a flop, making the less risky CD medium tempting for third party companies.[101]

As fifth generation games became more complex in content, sound and graphics, games began to exceed the limits of cartridge storage capacity. Nintendo 64 cartridges had a maximum of 64 MB of data,[102] whereas CDs held 650 MB.[90][103] Because of this space limitation, Nintendo 64 games typically have fewer textures and shorter music tracks.[104] Software ported from other platforms was often heavily compressed or redesigned with the storage limits of a cartridge in mind. Due to the cartridge's space limitations, full motion video was not usually feasible for use in cutscenes. When it was present, it was heavily compressed to fit on the cartridge and usually of very brief length. Some third party companies also complained that they were at an unfair disadvantage when publishing games for Nintendo consoles, since Nintendo owned the manufacturing plant where cartridges for their consoles are made and therefore could sell their first party games at a lower price.[62]

The era's competing systems from Sony and Sega (the PlayStation and Saturn, respectively) used CD-ROM discs to store their games.[105] As a result, game developers who had traditionally supported Nintendo game consoles were now developing games for the competition.[105] Some third-party developers, such as Square and Enix, whose *Final Fantasy VII* and *Dragon Warrior VII* were initially planned for the Nintendo 64,[106] switched to the PlayStation, citing the insufficient storage capacity of the N64 cartridges.[107] Some who remained released fewer games to the Nintendo 64; Konami released fifty PlayStation games, but only thirteen for the Nintendo 64. New Nintendo 64 game releases were infrequent while new games were coming out rapidly for the PlayStation.[108]

Through the difficulties with third parties, the Nintendo 64 supported popular games such as *GoldenEye 007*, giving it a long market life. Additionally, Nintendo's strong first-party franchises[109] such as *Mario* had strong name brand appeal. Second-parties of Nintendo, such as Rare, helped.[108]

Nintendo's controversial selection of the cartridge medium for the Nintendo 64 has been cited as a key factor in Nintendo losing its dominant position in the gaming market. Some of the cartridge's advantages are difficult for developers to manifest prominently,[102][103][108] requiring innovative solutions which only came late in the console's life cycle.[97][110][111]

One of its technical drawbacks is a limited texture cache, which can hold textures of limited dimensions and reduced color depth, which must be stretched to cover larger in-game surfaces. Its vintage ROM cartridges are constrained by small capacity and high production expenses, compared to the compact disc format used by its chief competitors. Some third-party publishers that supported Nintendo's previous consoles reduced their output or stopped publishing for the console; the Nintendo 64's most successful games came from first-party or second-party studios

Emulation

Several Nintendo 64 games have been released for the Wii's and Wii U's Virtual Console service and are playable with the Classic Controller, GameCube controller, Wii U Pro Controller, or Wii U GamePad. There are some differences between these versions and the original cartridge versions. For example, the games run in a higher resolution and at a more consistent framerate than their Nintendo 64 counterparts. Some features, such as Rumble Pak functionality, are not available in the Wii versions. Some features are

also changed on the Virtual Console releases. For example, the VC version of *Pokémon Snap* allows players to send photos through the Wii's message service, while *Wave Race 64*'s in-game content was altered due to the expiration of the Kawasaki license. Several games developed by Rare were released on Microsoft's Xbox Live Arcade service, including *Banjo-Kazooie*, *Banjo-Tooie*, and *Perfect Dark*, following Microsoft's acquisition of Rareware in 2002. One exception is *Donkey Kong 64*, released in April 2015 on the Wii U Virtual Console, as Nintendo retained the rights to the game.

Several unofficial emulators have been developed in order to play Nintendo 64 games on other platforms, such as PCs.

Accessories

A number of accessories were produced for the Nintendo 64, including the Rumble Pak and the Transfer Pak.

The controller was shaped like an "M", employing a joystick in the center. *Popular Electronics* called its shape "evocative of some alien space ship". While noting that the three handles could be confusing, the magazine said "the separate grips allow different hand positions for various game types".[44]

64DD

Nintendo released a peripheral platform called 64DD, where "DD" stands for "Disk Drive". Connecting to the expansion slot at the bottom of the system, the 64DD turns the Nintendo 64 console into an Internet appliance, a multimedia workstation, and an expanded gaming platform. This large peripheral allows players to play Nintendo 64 disk-based games, capture images from an external video source, and it allowed players to connect to the now-defunct Japanese Randnet online service. Not long after its limited mail-order release, the peripheral was discontinued. Only nine games were released, including the four *Mario Artist* games (*Paint Studio*, *Talent Studio*, *Communication Kit*, and *Polygon Studio*). Many more planned games were eventually released in cartridge format or on other game consoles. The 64DD and the accompanying Randnet online service were released only in Japan, though always having been announced for America and Europe.

To illustrate the fundamental significance of the 64DD to all game development at Nintendo, lead designer Shigesato Itoi said: "I came up with a lot of ideas because of the 64DD. All things start with the 64DD. There are so many ideas I wouldn't have been allowed to come up with if we didn't have the 64DD". Shigeru Miyamoto concluded: "Almost every new project for the N64 is based on the 64DD. ... we'll make the game on a cartridge first, then add the technology we've cultivated to finish it up as a full-out 64DD game".[112]

Technical specifications

Hardware

The Nintendo 64's central processing unit (CPU) is the NEC VR4300.[113] *Popular Electronics* said it had power similar to the Pentium processors found in desktop computers.[44] Except for its narrower 32-bit system bus, the VR4300 retained the computational abilities of the more powerful 64-bit MIPS R4300i,[113] though software rarely took advantage of 64-bit data precision operations. Nintendo 64 games generally used faster (and more compact) 32-bit data-operations,[114] as these were sufficient to generate 3D-scene data for the console's RSP (Reality Signal Processor) unit. In addition, 32-bit code executes faster and requires less storage space (which is at a premium on the Nintendo 64's cartridges).

In terms of its random-access memory, or RAM, the Nintendo 64 is one of the first modern consoles to implement a unified memory subsystem, instead of having separate banks of memory for CPU, audio, and video, for example.[115] The memory itself consists of 4 megabytes of RDRAM, made by Rambus. The RAM is expandable to 8 MB with the Expansion Pak. Rambus was quite new at the time and offered Nintendo a way to provide a large amount of bandwidth for a relatively low cost.

The sound chip is a 64-bit DSP running at 44.1 kHz.[99]

The system allows for video output in two formats: composite video[116] and S-Video. The composite and S-Video cables are the same as those used with the earlier SNES and later GameCube systems.

The Nintendo 64 supports 16.8 million colors.[117] The system can display resolutions from 320 × 240 up to 640 × 480 pixels. Most games that made use of the system's higher resolution 640 x 480 mode required use of the Expansion Pak RAM upgrade; there were a number however which did not,[118] such as Acclaim's NFL Quarterback Club series and EA Sports 2nd generation Madden, FIFA, Supercross, and NHL games which arrived on the system. The majority of games used the system's low resolution 320 × 240 mode.[118] A number of games also support a video display ratio of up to 16:9 using either Anamorphic widescreen or Letterboxing.

The Nintendo 64 motherboard, showing CPU, RCP, and RDRAM

The Nintendo 64 was one of the first gaming consoles to have four controller ports. According to Shigeru Miyamoto, Nintendo opted to have four controller ports because the Nintendo 64 was their first console which could handle a four players split screen without significant slowdown.[119]

Color variants

The Nintendo 64 comes in several colors. The standard Nintendo 64 is dark gray, nearly black,[120] and the controller is light gray (later releases in the U.S. and in Australia included a bonus second controller in Atomic Purple). Various colorations and special editions were released.

Most Nintendo 64 game cartridges are gray in color, but some games have a colored cartridge.[121] Fourteen games have black cartridges, and other colors (such as yellow, blue, red, gold and green) were each used for six or fewer games. Several games, such as *The Legend of Zelda: Ocarina of Time*, were released both in standard gray and in colored, limited edition versions.[122]

A Nintendo 64 console and controller in Fire-Orange color

Programming characteristics

The programming characteristics of the Nintendo 64 present unique challenges, with distinct potential advantages. *The Economist* described effective programming for the Nintendo 64 as being "horrendously complex".[123] As with many other game consoles and other types of embedded systems, the Nintendo 64's architectural optimizations are uniquely acute, due to a combination of oversight on the part of the hardware designers, limitations on 3D technology of the time, and manufacturing capabilities.

As the Nintendo 64 reached the end of its lifecycle, hardware development chief Genyo Takeda repeatedly referred to the programming challenges using the word *hansei* (Japanese: 反省 "reflective regret"). Looking back, Takeda said "When we made Nintendo 64, we thought it was logical that if you want to make advanced games, it becomes technically more difficult. We were wrong. We now understand it's the cruising speed that matters, not the momentary flash of peak power".[124]

Regional lockout

Nintendo initially stated that while the Nintendo 64 units for each region use essentially identical hardware design, regional lockout chips would prevent games from one region from being played on a Nintendo 64 console from a different region.[125] Following the North American launch, however, they admitted that the cartridges contain no such chips, and the regional lockout is enforced by differing notches in the back of the cartridges.[126]

See also

- List of Nintendo 64 ROM file formats

Notes

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External links

- *Billboard Magazine* of May 18, 1996, p.58 covering the launch of Nintendo 64, including Yamauchi's explanation of cartridge strategy and negotiations about Netscape's online strategy for Nintendo 64
- "Why Netscape Almost Didn't Exist", on Andreesson's choice to cofound Netscape instead of working on N64, and later proposing N64's first online strategy
- "Nintendo 64". Archived from the original on October 17, 2007.
- Index of all Nintendo 64 promotional videos
- US Patent for the N64
- The Most Complete N64 Game Release list by NESWORLD